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COLOR DEFECTIVES' JUDGMENTS OF SIGNAL LIGHTS AT SEA: A REPLICAT--ETC(U)
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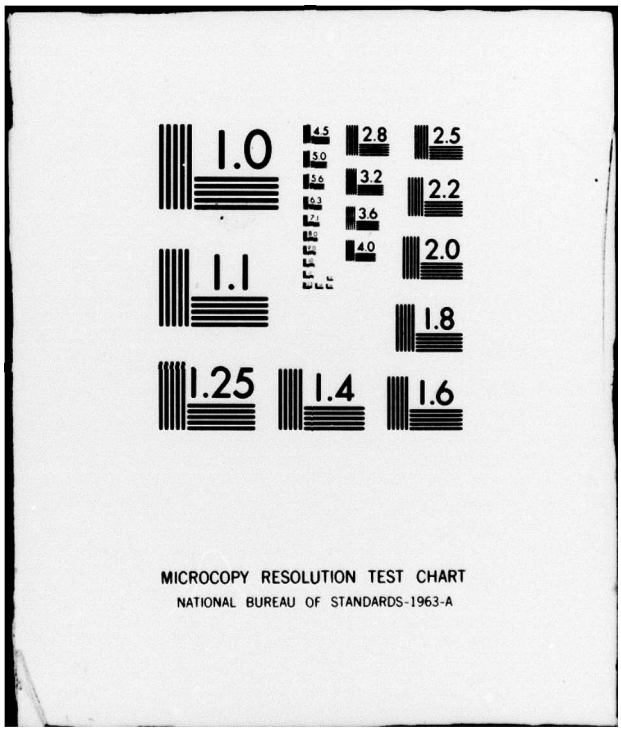
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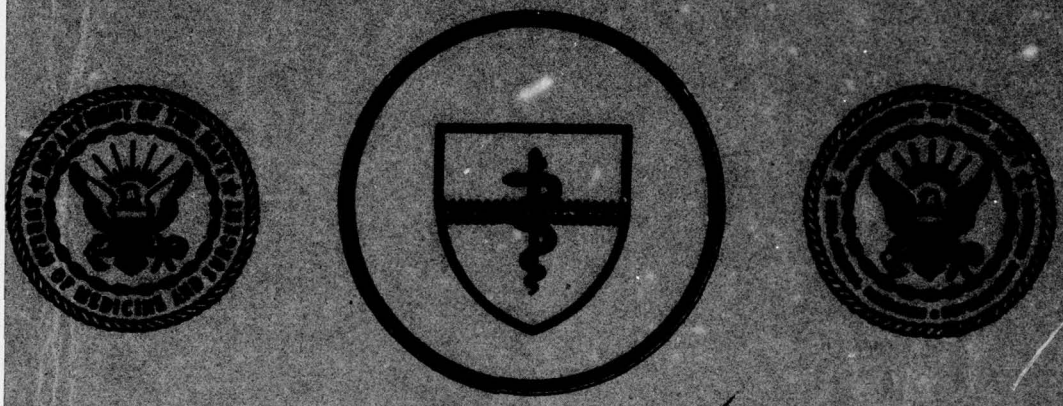

REPORT NUMBER 897

COLOR DEFECTIVES' JUDGMENTS OF SIGNAL LIGHTS AT SEA: A Replication

by

Jo Ann S. Kinney, Helen M. Paulson
and
Arthur N. Beare

Naval Medical Research and Development Command
Research Work Unit M0100-PN.001-1005

Released by:

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28 June 1979

(6) COLOR DEFECTIVES' JUDGMENTS OF SIGNAL LIGHTS AT SEA: A REPLICATION.

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Helen M. Paulson [redacted].
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PROBLEM

To determine if the large individual differences in the ability of color-defective men to judge signal lights at sea are reliable or simply a matter of random variation.

FINDINGS

There was a high correlation between the performance of men on two separate, realistic tests, indicating the differences in ability are real.

APPLICATIONS

While color defectives on the average cannot perform as well as color normals in judging lights at sea, some color-defective individuals do well. If these superior men could be identified, they could be utilized as line officers, thus filling critical needs for additional men.

ADMINISTRATIVE INFORMATION

This investigation was conducted as a part of Naval Medical Research and Development Command Research Work Unit M0100-PN.001-1005 -- "Evaluation of current color vision standards for submariners". The manuscript was submitted for review on 30 May 1979, approved for publication on 28 June 1979 and designated as NavSubMedRschLab Report No. 897.

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ABSTRACT

The ability of various types of color defective men to judge colored lights at sea was tested on two separate occasions with comparable results. While color normals performed the task very well, color defectives on the average did not. Nevertheless, some individuals in almost all categories of defect did perform well and these individual differences were highly reliable.

The ability of color defectives to judge the colors of signal lights at sea, under realistic conditions, was reported previously.[1] Eighty-one color defectives, categorized as to type and degree of defect, made judgments of the color of red, green, and white signal lights viewed at night at distances of one, two, and three miles. The color defectives did poorly, compared to normals, particularly at the greater distances. Surprisingly, there was no systematic relation between performance and degree of defect, but a large range of individual differences in performance within each category of defect. Some of the color defectives, particularly among the deutans, did nearly as well as color normals. The range from worst to best performance was almost identical for the groups of mild, moderate, severe and dichromatic deutans. While 67% of the mild deutans did as well as the worst color normal, 39% of the severe and dichromatic deutans also did.

In attempting to explain these individual differences, we analyzed and discarded a variety of factors unrelated to color vision, such as acuity, motivation, and experience. We did not, however, dismiss the possibility that these data might be simply the result of random variations in response among the population of color defectives. Consequently we have repeated the experiment, using a new group of subjects. In order to determine the reliability of the original finding, the experiment was repeated, in its entirety, on two consecutive nights.

Complete experimental procedures are found in the previous report.[1] All details of this study, including the lights themselves, the approximate observing distances (one, two, and 2.6 miles), the method of presentation, the method of classifying subjects, etc., were identical. In brief, 120 signal lights (30 each of red, green, white, and no light) were presented one at a time for ten seconds to the subjects, both color defective and normal, who reported the colors they perceived. The only differences between this and the previous study were the subjects, the location (Long Island Sound at Avery Point, Groton, CT), the weather conditions, and, most importantly, the fact that the experiment was repeated on two consecutive nights with the same subjects.

Atmospheric conditions on both nights were poorer than during the previous study in the Chesapeake Bay. Consequently, the distant boat was moved in to about 2.6 miles so that the color normals could see its lights. The first night was hazy with visibility limited to three miles. The second night was somewhat clearer with visibility about 5 miles. The view from shore again was of tiny colored lights against a dark surround.

Twenty-eight color-defective individuals, 19 deutans and 9 protans, were categorized as before, using the battery of tests (Pseudo-isochromatic plates, the Farnsworth Lantern, D-15, H-16, and the Hecht-Schlaer anomaloscope). Of these, twenty-two completed the experiment on both nights.

The overall percentages of correct judgments of the red, green, and white signal lights are presented in Table I for these 22 subjects. Once again, the color normals have significantly higher percentages of correct responses than do the color defectives and the deutans are in general better than the protans. While all subjects improved on the second night of testing, this must be attributed to a combined effect of familiarization with the task and improvement in the weather. Most important is the finding of a product-moment correlation of .88 between the performance of the color defectives on the two nights; a rank order correlation yielded the similar value of .94.

Table I. Overall percentage of correct judgments of red, green, and white signals.

Subjects	N	Day 1	Day 2
Normals	6	96.7 ± 5.1	99.6 ± 0.6
Protans			
Mild	1	80.2	93.3
Moderate	3	58.4 ±24.9	80.2 ±20.0
Sev. & Dich.	3	28.4 ± 6.5	56.2 ±18.6
Deutans			
Mild	8	82.6 ± 9.5	95.8 ± 5.9
Moderate	1	93.8	99.5
Sev. & Dich.	6	71.0 ±18.0	88.0 ± 7.3
All CD	22	69.1 ±23.0	86.0 ±16.5

$r_{tt} = .878$

While the relatively small number of subjects in the present experiment precludes detailed comparison with the previous data, there were two groups of subjects with sufficient numbers for this purpose. The percentage of correct judgments for the various signal colors at the three distances are shown for the two studies in Fig. 1; data for the group of mild deutans are at the top and for severe and dichromatic deutans at the bottom. Only the first night's data at Avery Point were employed in order to be comparable to the Annapolis Study. Both the percentages of correct judgments and the range, from worst to best overall performance, are comparable.

Thus we have obtained the same results for the same experiment conducted with different individuals in a different location with different weather and the results are reliable--they represent real and repeatable differences in performance among color-defective individuals.

Unfortunately, they represent repeatable differences that we cannot predict, by categorizing men according to a battery of good, widely used color vision tests. A possible solution, one successfully applied to a variety of other jobs,[2] is to design a test modeled as closely as possible after the task to be predicted. Consequently, we made a number of modifications to the Farnsworth Lantern in an attempt to duplicate the task at sea. Three modified Lanterns were tried: (a) the presentation of a single light as was the case at sea rather than the normal dual presentation, (b) a reduction in size to simulate the point sources at sea, (c) a change in the chromaticity of the green light to be more representative of Navy running lights. While modest improvements* in the correlations occurred, we do not consider them sufficiently large to recommend this procedure. A greater understanding of individual differences among color defectives is required before it will be possible to make predictions upon which to base a career decision or to risk the safety of a ship.

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* For example, the correlation, computed using only the color-defective subjects, for the standard Farnsworth Lantern was .44, for the best modification it was .56, and for a multiple correlation, using all three modifications, it was .62.

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2. Lakowski, R. Colour-matching ability--Can it be measured? J. Soc. Dyers & Colourists 84, 3-9 (1968).

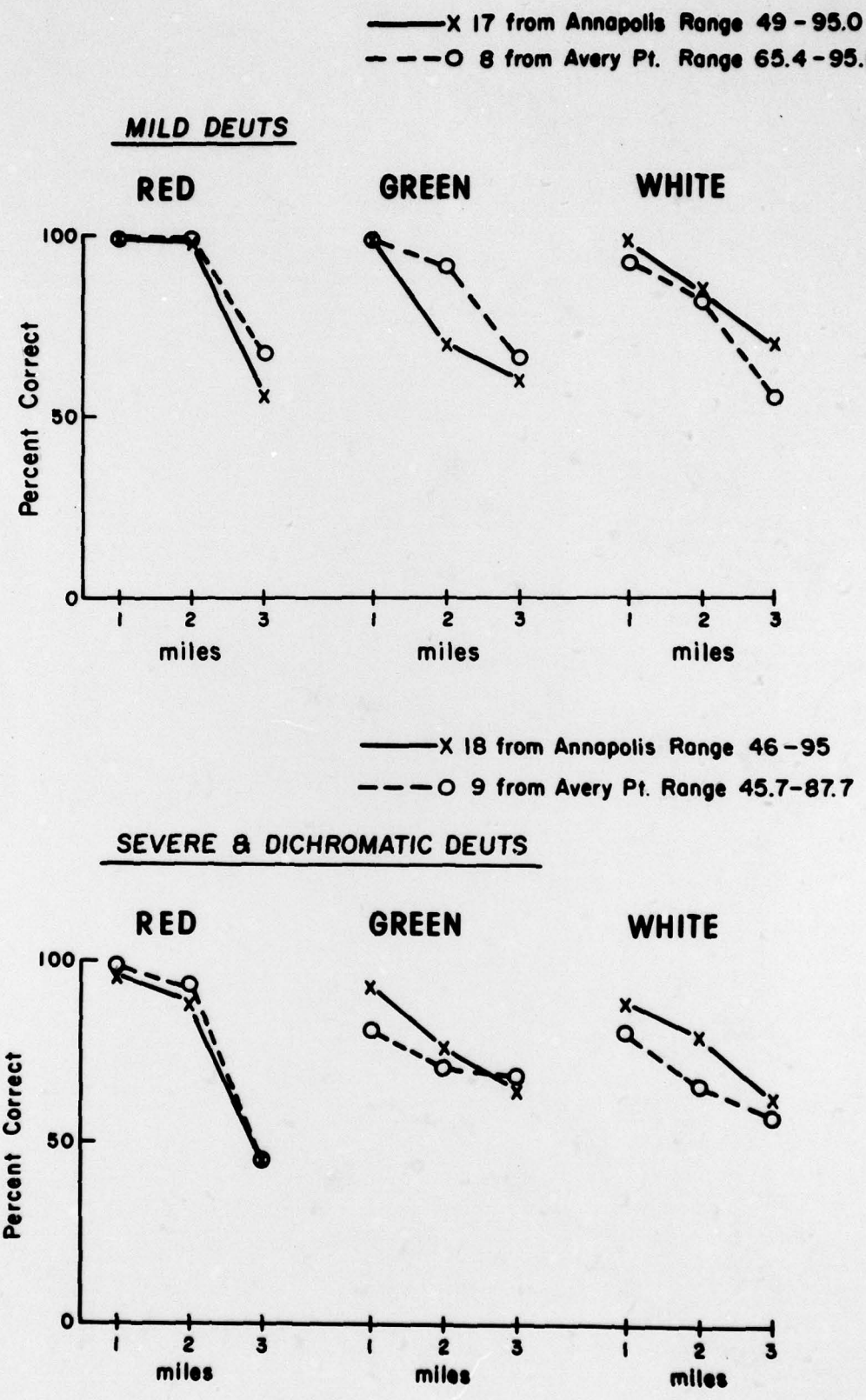

Fig. 1. A comparison of correct judgments of red, green, and white lights for two groups of mild deutans, at the top, and of severe and dichromatic deutans at the bottom.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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